

Mechanics revisions

- Forces of 2N, 3N, 4N, 5N and 6N act on a particle in the directions 030° , 090° , 120° , 210° and 330° respectively, Find the resultant force.
- A and B are two points on ground level, 60m apart. A particle is projected from A towards B with initial velocity 30ms^{-1} at an angle of 45° to the horizontal. At the same instant, a particle is projected from B towards A with the same initial velocity. Find when the particles collide and the height above the level of AB at which they collide.
- A horizontal force X is just sufficient to prevent a body of mass M from sliding down a rough plane of inclination θ . A horizontal force $4x$ applied to the same mass on the same rough plane, causes the mass to be on a point of moving up the plane, show that $5\mu \tan^2\theta - 3(\mu^2 + 1) \tan\theta + 5\mu = 0$.
- A train of mass 250Mg is travelling up a slope of 1 in 140 at a constant speed of 48kmh^{-1} . Taking frictional resistance to be $\frac{1}{60}$ of weight of the train.
 - Calculate the power which is being exerted.
 - Find also the maximum speed in kmh^{-1} that 450Kw could maintain on the level, if the frictional resistances were then increased to $\frac{1}{150}$ of the weight of the train.
- A vehicle of mass 500kg, travelling on a horizontal surface, has its engine working at a constant rate of 10 KW against a resisting force of $25V\text{N}$ where V is the speed in metres/second. Find
 - The maximum speed of the car
 - The time taken for the car to increase its speed from 5ms^{-1} to 15ms^{-1} .
- Particles with weights of 2N, 5N and 3N are acting at points (2, 3), (3, -1) and (-2, 5) respectively. Determine position of the centre of gravity.
- A particle is projected at an angle of 60° with a speed of 15m/s. If the point of projection is 5m above the horizontal ground, find the horizontal distance that the particle travels before striking the ground.
- Two bodies A and B of masses 5kg and 8kg respectively are travelling along the same straight line with constant speeds of 4ms^{-1} and 3ms^{-1} respectively. If they collide and coalesce,
 - find their common speed just after impact.
 - the loss in the kinetic energy of the bodies.
- A particle P starts from a point with a position vector $2\mathbf{j} + 2\mathbf{k}$ with a velocity $\mathbf{j} + \mathbf{k}$. A second particle Q starts at the same time from the point whose position vector is $-11\mathbf{i} - 2\mathbf{j} - 7\mathbf{k}$ with a velocity of $2\mathbf{i} + \mathbf{j} + 2\mathbf{k}$. Determine:
 - the time when they are closest together.
 - the shortest distance between the particles.
 - how far each particle has travelled by this time.
- A mass of 9kg rests on a rough horizontal table and is attached by two inelastic strings to masses 3kg and 5kg which hang over a light smooth pulley at opposite edges of a table if the coefficient of friction is $\frac{1}{5}$. Determine:

- a) acceleration of the system.
- b) tension in the string.
- c) the resultant force on the pulley.

11. Two uniform rods AB, AC each of weight W and length 10cm are smoothly hinged at A. the ends B and C rest on a smooth horizontal plane. An inextensible string joins B and C and the system is kept in equilibrium in a vertical plane with the string taut. An object of weight $2W$ climbs AC to a point E such that $AE = 8\text{m}$. Given that angle $BAC = 20^\circ$, determine in terms of W and θ .

- a) the reaction at the ends B and C.
- b) the tension in the string hence show that the reaction at the hinge A is given by $\frac{W}{10}\sqrt{(49\tan^2\theta + 4)}$.

12. A particle moves in a straight line and when its distance from a fixed point O is x metres, its retardation is $(5 + \frac{1}{2}x)\text{ms}^{-2}$. Given that its velocity is 20ms^{-1} when $x = 0$. Find the value of x when the particle first comes to rest.

13. The resultant of two forces $X\text{N}$ and 3N is 7N . If the 3N force is reversed, the resultant is $\sqrt{19}\text{N}$. Find the value of X and the angle between the two forces.

14. A box of mass 6kg is placed on a rough plane inclined at 45° to the horizontal. The coefficient of friction between the box and the plane is 0.5 . Find the magnitude of the horizontal force that must be applied to the box so that it moves up the plane with an acceleration of $2\sqrt{2}\text{ms}^{-2}$.

15. A car of mass 800kg is towing a trailer of mass 150kg on a level road frictional resistance to each vehicle amounts to 7N per kg of mass.

- a) Calculate the tension in the tow bar when the vehicles are travelling at a constant speed.
- b) The car and the trailer now climb a straight slope of inclination 1 in 20. If the frictional resistance are the same as before and the power of the engine is 50KW , calculate
 - i) The maximum speed up the slope
 - ii) The acceleration when the speed is 54kmh^{-1}

16. A car A is travelling at a constant velocity of 20kmh^{-1} due East and a cyclist B is travelling with a velocity of 16kmh^{-1} in the direction of the vector $(-4i + 3j)$. At noon A is 1.2km due North of B.

- a) Obtain an expression for the position vector of A and B at time t hours past noon.
- b) Find the position vector of A relative to B.
- c) Deduce that, if $d\text{km}$ is the distance between A and B, then $25d^2 = 36(100t^2 - 16t + 1)$. Hence show that the minimum separation between A and B is 720m and find the time at which this occurs.

17. Forces of magnitude 5N , 4N , 7N , 2N and 8N act along the directions PQ, QR, SR, SP and PR respectively of a rectangle PQRS whose length is $6b$ and width $3b$. The direction of the force being indicated by the order of the letters.

- a) Find the magnitude and direction of the resultant of the forces.
- b) Show that the line of action of the resultant force cuts PQ at a distance $\frac{1}{2}b$ from P.

18. Two particles of masses 1kg and m kg hang vertically, one at either end of an inextensible string passing over a smooth fixed pulley. When the particles are released from rest, the 1kg mass moves upwards with an acceleration of 4.9 ms^{-2} .

Determine the:

- (i) tension in the string;
- (ii) value of m .

19. The position vectors of two moving particles are given by $r_1 = (2 + 4t^2)i + (3t + 2)jm$ and $r_2 = 6ti + (4 + t)jm$; where t is time in seconds. Given that the particles collide, find the:

- (i) Position vector of the point of collision;
- (ii) Velocity of the first particle relative to the second particle at the instant of collision.

20. A particle of mass 2kg executes simple harmonic motion about 0. When the particle is 1.5m from 0, its speed is 4 ms^{-1} and the resultant force acting on it is 12N. Find the:

- i. Period and amplitude of motion;
- ii. Least time the particle takes to reach 0.

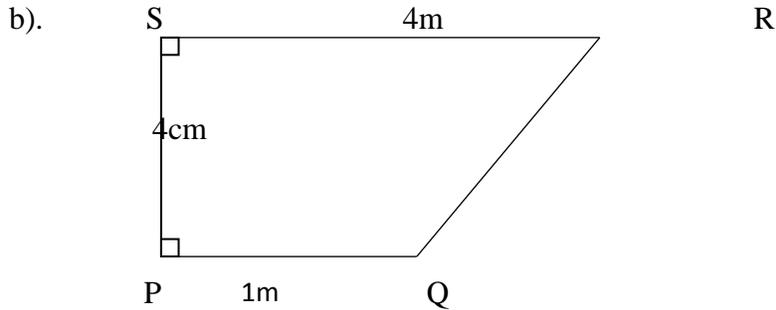
21. . a) Masaka is South west of Kampala. To a passenger in a Kampala – Masaka bound bus,

travelling at 120 kmh^{-1} , a steady wind appears to blow from the west. When the speed of the bus reduces to 90 kmh^{-1} , the wind appears to the passenger to be blowing from $\text{W}30^\circ\text{N}$. Find the true direction and speed of the wind.

b) A body A is travelling with a constant velocity of 20 kmh^{-1} due west and body B is travelling in the direction of the vector $(-4j + 3j)$ at 16 kmh^{-1} . At a certain instant A is 1.2km due north of B. Taking A as the origin at this instant, show that the position vector r of A relative to B at any time t is given by $5r = 6(-6tl + (1 - 8t)j)$; where t is in hours. Hence show that the minimum distance between A and B is 0.72km.

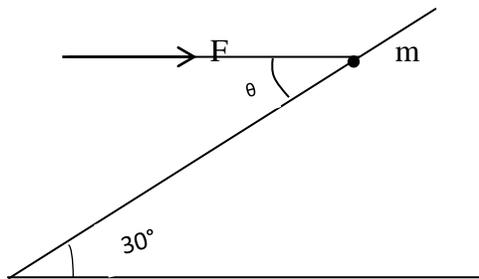
22. a) Forces of 5N, 3N, 4N and 6N act along the sides AB, BC, CD and DA of a square of side 2m. (i) Find the distance from A at which the line of action of the resultant cuts AB

- (ii) Two additional forces of $\sqrt{2}$ N and $2\sqrt{2}$ N act respectively along diagonals AC and BD. Show that the system reduces to a couple and find its moment.



The figure above show a lamina in the shape of a trapezium. The Centre of gravity of the lamina is a distance of 1.5m from side PS and its mass is 1.8kg. Find the least force which must be applied at point R for the lamina to be in equilibrium.

23.



A force FN , maintains a particle of mass $m\text{kg}$ in equilibrium on a smooth plane of angle 30° to the horizontal. If the force acts at an angle θ to the plane and the normal reaction of the plane on the particle is $1.5mg$, find the values of θ .

24. Two forces have magnitudes $5N$ and FN . If the resultant force has magnitude $6N$, and acts at an angle 40° to the force of magnitude $5N$, calculate the value of F and direction in which this force acts.

25. A particle is projected with initial speed 12ms^{-1} at an upward angle of 30° to the horizontal from the top of a tower 25m high. Find (i) how long the particle is in flight before it hits the ground. (ii) the horizontal distance from the foot of the tower to the landing site.

26. A car of mass 750 kg is traveling along a horizontal road. If the resistances to motion total $240N$, and the car's engine is working at a constant rate of 12 kw . Find the maximum velocity of the car up a hill inclined at $\sin^{-1}\left(\frac{1}{25}\right)$ to the horizontal.

27. A box of mass 400 grams suspended by a light elastic string of natural length 50 cm and modulus of elasticity $20N$ rests in equilibrium at a point E

- (a) Find the extension of the string.
- (b) If the box is projected vertically downwards at 0.5ms^{-1} from equilibrium position;
- Show that the box moves with simple harmonic motion.
 - If $EA = 1\text{ cm}$ and $EB = 3\text{ cm}$, find the time taken by the box to move directly from A to B.

28. A particle at point A travels on a bearing of 060° at 12 ms^{-1} . A second particle starts at point B, which is 30m due East of point A, and has a maximum speed of 5 ms^{-1} . Find the

- Course that the second particle must set to get as close as possible to the first particle.
- Closest distance between the particles and the time at which this will occur

29. To a woman in a car travelling at 20Kmh^{-1} North East, the wind appears to blow from the west with speed of 16Kmh^{-1} . Find the actual velocity of the wind.

30. A particle moves with simple harmonic motion about a mean position O. The amplitude of the motion is 65cm and the periodic time is $\pi/2$ seconds. Find how far the particle is from O when its speed is 2ms^{-1} .

31. Three particles of masses 4kg, 6kg, 2kg are located at points (0, 4), (9, 0) and (0, -4) respectively. Determine the coordinates for the centre of gravity for the system.

32.a) A particle is projected from a point O with speed, u , at an angle θ to the horizontal. Show that its height, y , above O when it has travelled s distance x horizontally is given by

$$y = x \tan \theta - \frac{gx^2 \sec^2 \theta}{2u^2}$$

(b) After 2 seconds of projection, a particle projected from the top of a vertical cliff 6m high with speed, $u\text{ms}^{-1}$ at angle of elevation θ to the horizontal, passes just above the top of a vertical pole post which is 4m high and 8m horizontally away from the base of the cliff.

- Show that $\tan \theta = 2.2$
- Find the value of u .

33. Blocks A and B are of masses 5kg and 8kg respectively are connected by a light inextensible string passing over a smooth pulley. Block A is resting on a rough horizontal table while block B hangs freely when the system is released from rest. Block B travels a distance of 40cm in 0.5 seconds. Calculate;

- Acceleration of the blocks.
- Coefficient of friction between the plane and the block A.
- Reaction of the pulley on the string.

34. At point A(0, -4), B(2, 1), C(1, 3) and D(-4, -2). There are forces $\begin{pmatrix} -1 \\ -5 \end{pmatrix}$, $\begin{pmatrix} -2 \\ -3 \end{pmatrix}$, $\begin{pmatrix} 1 \\ 4 \end{pmatrix}$ and $\begin{pmatrix} 2 \\ 4 \end{pmatrix}$ N respectively. (06 marks)

- Prove that the resultant is a couple and find its moment.

- (ii) If the force D is halved, determine the magnitude of the resultant force. Find also equation of the line of action of the resultant.
- b) A particle of weight 12N is attached to a point B of a light inextensible string whose other end A is fixed to a point on the ceiling of a roof. A horizontal force of magnitude P is applied on the particle B to keep it in equilibrium with the string inclined at 60° to the downward and vertical. Find the value of P and tension in the string.
35. A particle of mass 0.5kg moves such that its displacement is given by $\mathbf{r} = (4\sin 2t)\mathbf{i} + (2\cos t - 1)\mathbf{j}$ meters: Find the;
- Speed of particle at $t = \pi/6$ seconds.
 - force acting on the on the particle at tiny time, t
36. A particle of mass 5kg hangs on a fixed point O by a light inextensible string. It is pulled aside by a horizontal force P and rests in equilibrium at an angle of 30° to the vertical. Determine P and the tension in the string.
36. At time, $t = 0$, the position vectors and velocities of two bodies A and B are as follows;
- $$\mathbf{r}_A = (3\mathbf{i} + \mathbf{j} + 5\mathbf{k})\text{m}, \mathbf{V}_A = (4\mathbf{i} + \mathbf{j} - 3\mathbf{k}) \text{ms}^{-1}$$
- $$\mathbf{r}_B = (\mathbf{i} - 3\mathbf{j} + 2\mathbf{k})\text{m}, \mathbf{V}_B = (\mathbf{i} + 2\mathbf{j} + 2\mathbf{k}) \text{ms}^{-1}$$
- Determine;
- the position vector of B relative to A at time, t.
 - the value of the time when A and B are closest.
 - the least distance between A and B.
37. To one end of a light string passing over a smooth fixed pulley is attached to a particle of mass 8kg and to the other end a light pulley. Over this pulley passes a light string to the end of which are attached particles of mass 5kg and 3kg respectively. Find the;
- acceleration of the 8kg mass
 - tensions in the strings attached to the system.
38. a) Particles of masses 2kg, 5kg, and 3kg at point whose position vectors are $(2\mathbf{i} + 3\mathbf{j})$, $(3\mathbf{i} - \mathbf{j})$ and $(-2\mathbf{i} + 5\mathbf{j})$. Find the position vector of the centre of gravity.
- b) A sheet of metal in form of a square ABCD with an isosceles triangle described on the BC. If the side of the square is 12cm and the height of the triangle is 9cm. Find the distance of the centre of gravity of the sheet from the line AD.
39. The speed of a taxi decreased from 90kmhr^{-1} to 18kmhr^{-1} in a distance of 120m. Find the speed of the taxi when it had covered a distance of 50m.
40. A ball is projected vertically upwards and it returns to its point of projection 3 seconds later. Find the;
- speed with which the ball was projected
 - greatest height reached.

41. P, Q and R are points on a straight road such that $PQ = 20\text{m}$, and $QR = 55\text{m}$. A cyclist moving with uniform acceleration. Passes P and notices that it takes him 10s and 15s to travel between (P and Q) and (Q and R) respectively. Find his uniform acceleration.

42. A particle starts from rest at the origin and moves along the x- axis with acceleration give, by $a = (6 - 20t) \text{ms}^{-2}$. Find the maximum speed of the particle and the distance travelled upon reaching maximum speed.

43. A particle of mass $z \text{ kg}$ resting on a rough horizontal plane is pulled by a force of magnitude 11.3 N inclined at an angle of 60° to the horizontal. If the particle does not move, find the minimum value of the coefficient of friction between the particle and the plane.

44. A uniformly accelerating body starts with speed $u \text{ ms}^{-1}$ and in successive times of t seconds, travels distances n and $2n$ metres respectively. Show that the acceleration is $\frac{4u^2}{n}$

b) A car moving with uniform acceleration in a straight line travels 29 m in the fifth second and a distance 76m in the sixth second of its motion. Determine the initial velocity and acceleration of the body.

45. Forces $\begin{pmatrix} 5 \\ 2 \end{pmatrix}$, $\begin{pmatrix} 4 \\ 4 \end{pmatrix}$ and $\begin{pmatrix} 3 \\ -1 \end{pmatrix}$ act at points with respective vectors $\mathbf{i}-3\mathbf{j}$, $4\mathbf{i}+2\mathbf{j}$ and $-2\mathbf{i}+\mathbf{j}$ respectively. Find;

- The magnitude of the resultant force.
- The equation of the line of action of the resultant.

46. A car of mass 2000kg travels along a level road against a constant resistance of 1200N . The car develops a constant power of 18kW . Calculate the;

- Maximum speed of the car on the road
- Acceleration of car when its speed is 10ms^{-1} .

47. A particle moving with an acceleration given by the expression

$\mathbf{a} = 3e^{-t}\mathbf{i} + 5\cos t\mathbf{j} - 4\sin t\mathbf{k}$ is located at $(2, -3, 4)$ and has the velocity $\mathbf{v} = 6\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}$ at time $t=0\text{s}$. Find

- Velocity
- Displacement at any time, t

48. A block of mass 6.5kg is projected with velocity of 4ms^{-1} up a line of greatest slope of a rough plane. The coefficient of friction between the block and the plane is $\frac{2}{3}$ and the plane makes an angle θ with the horizontal whose $\sin \theta = \frac{5}{13}$. The block travels a distance $d\text{m}$ up the plane before coming to rest.

- a) Calculate the kinetic energy of the block.
- b) Express in terms of d the potential energy gained by the block in determining coming to rest.
- c) The work done against friction by the block in coming to rest. Hence, calculate the value of d (take $g=10\text{ms}^{-1}$).

49. Two particles P and Q move with constant velocities of $(-6\mathbf{i} + \mathbf{k})\text{ms}^{-1}$ and $(-5\mathbf{i} + \mathbf{j} + 7\mathbf{k})\text{ms}^{-1}$ respectively. Initially, P is at the point with position vector $(\mathbf{i} + 2\mathbf{j} + 3\mathbf{k})\text{m}$ and Q is at the point with position vector

$(4\mathbf{i} + 14\mathbf{j} + \mathbf{k})\text{m}$. Find the;

- a) Time for which the distance between P and Q is least.
- b) Distance of P from the origin at the time when the distance between P and Q is least.
- c) Least distance between P and Q.

50. A bullet is fired from a point P which is at the top of a hill 50m above the ground.

The speed with which the bullet is fired is 140ms^{-1} and it hits the ground at a point Q which is at a horizontal distance 200m from the foot of the bill. Find the,

- (i) two possible values of angle of projection
- (ii) two possible times of flight.
- (iii) angle with which the bullet hits the grounds.

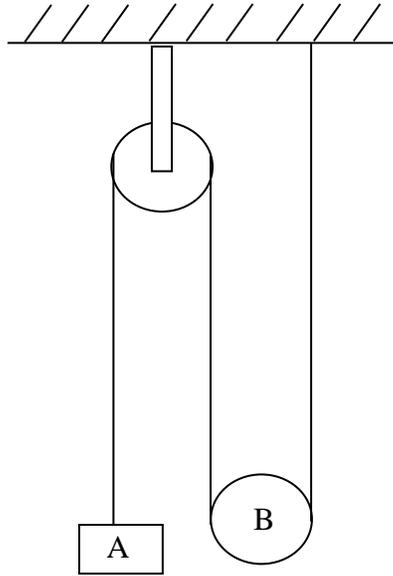
51. A bullet of mass 30gm is fired horizontally into a small block of wood of mass 8kg which is suspended by a string 2m long. The bullet remains embedded in the wood and the block rises until the string makes an angle of 30° with the vertical. Find the velocity of the bullet.

52. A car of mass 1000 kg moves with its engine shut off down a slope of inclination, θ , where $\sin \theta = 1/20$, at a steady speed of 15 ms^{-1} .

- (i) Find the resistance to the motion of the car,
- (ii) Calculate the power delivered by the engine when the car ascends the same inclination at the same steady speed, assuming that resistance to motion is unchanged.

53. (a) A particle of mass 5 kg is placed on a smooth plane whose height is 4 m and length 20m. The particle is connected by a light string passing over a smooth pulley at the top of the plane to a mass of 3 kg hanging freely. Find the common acceleration and the tension of the string.

(b) The diagram below shows a particle A of mass 0.5 kg attached to one end of an inextensible light string passing over a fixed light pulley and under a moveable light pulley B, the other end of the string is fixed to a ceiling.



- i) What mass should be attached to B for the system to be in equilibrium?
 - ii) If B is 0.8 kg, what are the accelerations of particle A and pulley B?
- (c) A ship A is traveling on a course of 060° at a speed of $30\sqrt{3}$ and a ship B is traveling at 20kmh^{-1} . At noon B is 260km due east of A.

(i) Find the course B must take to come as close as possible to A.

(ii) Find the time when A and B are closest together and the shortest distance.

54. Forces 1N, 4N, 2N and 6N act along the sides AB, BC, CD, and DA of a square ADCD of Side 2m. Find the ;(i) Resultant force (ii) If A (0, 0) is the origin, find the moment of each force from A and find the sum of the moments.

55. (a) ABCD is a square of side 2m. Forces of magnitudes 3N, 5N, 7N and 2N act along sides DA, AB, BC and CD respectively. Calculate :(i) the magnitude of the resultant of the

forces and the angle made by the resultant with AD.(ii) the sum of the moments of the forces about A

(iii) the distance from A of the point where the line of action of the resultant of the forces cuts DA produced.(iv) the equation of the line of action of the resultant.

(b) A uniform ladder 5m long, mass 20 kg rests on a rough horizontal ground and against a smooth vertical wall. It is inclined at an angle of 30° to the vertical. Find the normal reactions at each end of the ladder.

56.a) A car traveling at 54 kmh^{-1} is brought to rest with uniform retardation in 5 seconds. Find its retardation in ms^{-2} and distance it travelled in this time.

b) A cyclist was timed between successive trading centres P; Q and R, each 2 km apart. It took $\frac{5}{3}$ minutes to travel from P to Q and 2.5 minutes from Q to R

Find (i) Acceleration

(ii) the velocity with which the cyclist passes point P

(iii) How much further the cyclist will travel before coming to rest if the Acceleration remains uniform.

57. A particle of mass 3 kg moves so that its position vector after t seconds is given by $\mathbf{r} = (3t^2 - 2t^3) \mathbf{i} - 2t\mathbf{j}$. Find the force acting on the particle at time $t = 2$ seconds.

58. (a) At noon, two planes P_1 and P_2 are sighted at places with position vectors and velocity vectors given as:

$$r_{p1} = \begin{bmatrix} 5 \\ -3 \\ 4 \end{bmatrix} \text{ km}$$

$$V_{p1} = \begin{bmatrix} 2 \\ 5 \\ 3 \end{bmatrix} \text{ kmh}^{-1}$$

$$r_{p2} = \begin{bmatrix} 7 \\ 5 \\ -2 \end{bmatrix}$$

$$V_{p2} = \begin{bmatrix} -3 \\ -15 \\ 18 \end{bmatrix} \text{ kmh}^{-1}$$

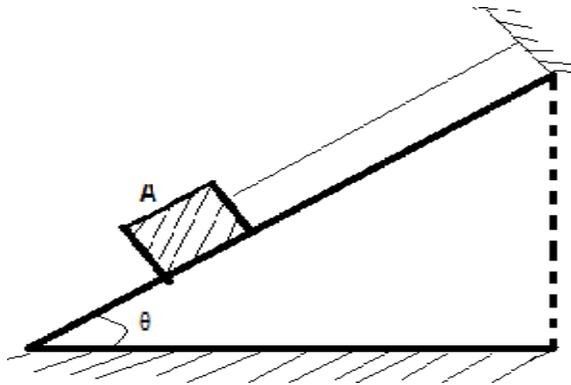
If the velocities, of the planes remain constant,

- (i) Find the positions of the planes a time t after noon.
- (ii) If after this time t , the planes collide (same point), find t and their distance from the origin.

b) A box of mass 5kg is at rest on a plane inclined at 30° to the horizontal. The coefficient of friction between the box and the plane is $2/5$. What minimum force applied parallel to the plane would move the box up the plane?

59. A car decelerated from a speed of 20ms^{-1} to rest in 8 seconds, falling short of its parking slot by 20m . By how much longer should the car have decelerated from the same speed so as to just reach the parking slot?

60.



A particle A of mass 5kg is kept at rest on a rough inclined plane of angle $\theta = \tan^{-1}(\frac{3}{4})$, by an inelastic string parallel to the line of greatest slope of the plane. Given that the coefficient of friction between the particle and the plane is $\frac{1}{2}$, find the minimum tension in the string.

61. Initially a particle travels with a speed of 20m/s in the direction $-4i + 3j$ and 5 seconds later its speed is 26m/s in the direction $12i - 5j$. Calculate the average acceleration of the particle in the 5 seconds.

62. (a) A particle of mass **800 grams** executes a simple harmonic motion of amplitude **0.4m** about a central point O. given that the particle is projected from O and

the period of motion is **6** seconds, find the;

- (i) velocity after **2** seconds
- (ii) force acting at **$t = 1\text{s}$** .

(b) An elastic string of natural length 0.5m and modulus of elasticity 9.8N carries a particle of mass 0.5kg. Calculate the;

- (i) energy stored in the string when the system is in equilibrium
- (ii) maximum speed, when the particle is stretched by 0.2m below its equilibrium position and then allowed to make vertical oscillations.

63. A car of mass **2000kg** developing a constant power of **20kW** ascends a slope 1 in 49 with a maximum speed of **10 ms⁻¹**. The non – gravitational resistance to the motion of the car is directly proportional to the car's speed.

(a) Calculate the

- (i) non – gravitational resistance at maximum speed
- (ii) acceleration of the car at a speed of **5ms⁻¹**

(b) If the car descends the same slope while developing the same power of **20kW**, calculate the maximum speed the car attains.

64. A uniform ladder of length $2l$ and weight, W rests in a vertical plane with one end against a rough vertical wall and the other against a rough horizontal surface, the angles of friction at each angle being $\tan^{-1}\left(\frac{1}{3}\right)$ and $\tan^{-1}\left(\frac{1}{2}\right)$ respectively.

- (a) If the ladder is in limiting equilibrium at either end, find θ , the angle of inclination of the ladder to the horizontal
- (b) A man of weight 10 times that of the ladder begins to ascend it, how far will he climb before the ladder slips.

65. Two particles P and Q are moving along a straight path. When Q is ahead of P by $14m$ the

speed of Q is $16 m s^{-1}$ and that of P is $25 m s^{-1}$. Given that P and Q have a constant retardation

of $6 m s^{-2}$ and $4 m s^{-2}$ respectively, find the distance Q has travelled when it is first overtaken by P.

66. A particle is projected from a point P with an initial speed of $78.4ms^{-1}$ at an angle of 30° with

the horizontal. Calculate the;

(i) velocity of the particle $\frac{1}{2}$ second after leaving P. (ii) greatest height reached

67. Forces of 2N, 4N, 3N and 2N act along the sides PQ, QR, RS, SP, of a square PQRS of side

3m. A force of 5N acts along QM where M is the mid-point of PS. The line of action of their resultant cuts PQ produced at K. Calculate

- the magnitude of this resultant
- the angle this resultant makes with PQ.

68. 13a) A particle of 1 kg is moving under the action of a constant force $\mathbf{F} = \mathbf{i} - 3\mathbf{j} + 4\mathbf{k}$ N. Find the

work done by \mathbf{F} when the particle moves from the point A with position vector $5\mathbf{j} + 2\mathbf{k}$ to the point B with position vector $3\mathbf{i} + \mathbf{k}$. If the speed of the particle at A is 6 m s^{-1} , find the

speed of the particle at B.

b) A small pulley is fixed at a height of 3m vertically above a point K of a horizontal rough table. A body of mass 6.5kg rests on the table at a distance 4m from K. A string, with one end fastened to the body, passes over the pulley and has a mass of 2.5kg hanging from the other end. Given that the body is on the point of slipping, calculate the coefficient of friction between the body and the table.

69. A particle of mass 4 kg is acted upon at time t by a force \mathbf{F} , where $\mathbf{F} = 8\mathbf{i} - 48t^2 \mathbf{j} + 72t\mathbf{k}$. At

time $t = 0$ the particle is at the point with position vector $\mathbf{i} - 5\mathbf{j} - \mathbf{k}$ and its velocity is $3(\mathbf{i} + \mathbf{j})$. Find the position vector of the particle at time $t = 2 \text{ s}$.

70. (a) A body of mass 3kg initially at rest is acted upon by three forces $\mathbf{F}_1 = (\mathbf{i} - \mathbf{j} + 2\mathbf{k})\text{N}$, $\mathbf{F}_2 = (2\mathbf{i} + 3\mathbf{j} + 2\mathbf{k})\text{N}$ and $\mathbf{F}_3 = (4\mathbf{j} - \mathbf{k})\text{N}$. Find the work done by the forces in a time of three seconds.

(b) A tractor of mass moves from rest down a slope of a certain inclination by a tractive force of 7500N. The resistance to its motion being 720N. (i) Calculate the gained kinetic energy.

71. A light inextensible string of length 170cm is attached at its ends to two points at the same level 130cm apart. The string carries a mass of 2kg. A horizontal force is applied to the mass causing the angle between the two sections of the string to be a right angle. Find the size of the horizontal force and the tension in the string. ($g = 10\text{m/s}^2$)

72. 6. A particle P is projected vertically upwards with a speed of $u\text{ ms}^{-1}$ from a point O on the ground; while at its highest point a second particle is projected vertically upwards with a speed $2u\text{ ms}^{-1}$ from point O . The particles collide at a point which is at a distance $x\text{ m}$ from the highest point of P . Prove that; $u^2 = 32g$

END